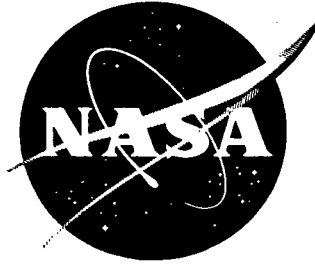


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**BIBLIOGRAPHY OF ARTICLES AND REPORTS
ON MINERAL-SEPARATION TECHNIQUES,
PROCESSES, AND APPLICATIONS**

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**BIBLIOGRAPHY OF ARTICLES AND REPORTS
ON MINERAL-SEPARATION TECHNIQUES,
PROCESSES, AND APPLICATIONS**

**Compiled by
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ABSTRACT

A bibliography of published articles and reports on mineral-separation techniques, processes, and applications is presented along with an author and subject index. This information is intended for use in the mineral-separation facility of the Lunar Receiving Laboratory at the NASA Manned Spacecraft Center and as an aid and reference to persons involved or interested in mineral separation.

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ON MINERAL-SEPARATION TECHNIQUES,
PROCESSES, AND APPLICATIONS

By Russell S. Harmon
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INTRODUCTION

The following is a bibliographic presentation of journal articles, books, and conference proceedings on mineral-separation techniques, processes, and applications published between 1920 and 1968. The bibliography contains 97 entries. Listings were obtained from two major sources: (1) compilations of references from published articles and (2) a search of the tables of contents of selected journals and books from the libraries at the Manned Spacecraft Center, The University of Texas at Austin, University of Houston, and Rice University.

The following persons were helpful in providing reprints and reference sources used in the bibliography: D. S. Barker, R. B. Coleman, G. B. Dalrymple, W. R. Foreman, W. R. Greenwood, and R. I. Tilling.

BIBLIOGRAPHY

1. Atherton, M. ; and Harrison, E. : A Note on Feed and Asymmetric Devices for Mineral Separation. *Mineral. Mag.*, vol. 35, no. 269, 1965, pp. 233-234.
2. Balint, A. ; and Fleming, M. G. : Selective Conditioning of Minerals in Gaseous Suspension With the Aid of Electrostatic Forces. Vol. I of VII International Mineral Processing Congress Technical Papers (New York), 1965, pp. 279-292.
3. Barsdate, R. J. : Rapid Heavy Mineral Separation. *J. Sediment. Petrol.*, vol. 32, no. 3, 1962, p. 608.
4. Bates, J. D. ; and Bates, B. H. : Evaluation of Heavy Mineral Separation Using Artificial Samples. *J. Sediment. Petrol.*, vol. 30, no. 1, Mar. 1960, pp. 148-153.
5. Beaufile, Jean P. : Mesure des Travaux d'Extraction Électrostatique. Modification de la Méthode de l'Électrode Vibrante. *Compt. Rend.*, vol. 256, no. 17, Apr. 22, 1963, pp. 3664-3667.

6. Bedford, Robert H.: Gravity Electrostatic Separation Process. Patent 2,116,613, Oct. 3, 1938.
7. Berg, Ernest L.: A Method for the Mineralogical Fractionation of Sediments by Means of Heavy Liquids and the Centrifuge. *J. Sediment. Petrol.*, vol. 7, no. 2, Aug. 1937, pp. 51-54.
8. Berg, G. A.: Notes on the Dielectric Separation of Mineral Grains. *J. Sediment. Petrol.*, vol. 6, no. 1, Apr. 1936, pp. 23-27.
9. Brien, Frederick B.: Foreign Developments and Research Activities. *Mining Eng.*, vol. 15, Feb. 1963, pp. 105-106.
10. Brown, Irvin C.: A Method for the Separation of Heavy Minerals of Fine Soil. *J. Paleontol.*, vol. 3, no. 4, Dec. 1929, pp. 412-414.
11. Browning, J. S.: Heavy Liquids and Procedures for Laboratory Separation of Minerals. U.S. Bur. of Mines Information Circ. 8007, 1961.
12. Carta, Mario: De Quelques Contributions á la Séparation Electrique des Minerais. *Fevne de l'Industrie Minerale*, vol. 49, no. 6, 1967, pp. 409-430.
13. Carta, Mario; Ferrara, G. F.; Del Fa, C.; and Alfano, G.: Contribution to the Electrostatic Separation of Minerals. Vol. I of VII International Mineral Processing Congress Technical Papers (New York), 1965, pp. 427-446.
14. Cheeseman, D. R.: A New Technique in Centrifugal Mineral Separation. *Can. Mineralogist*, vol. 6, 1957, pp. 153-155.
15. Clerici, Enrico: Ulteriori Ricerche sui Liquidi Pesanti per la Separazione dei Minerali. *Atti Reale Accad. Nazl. Lincei*, ser. 5, vol. 31, 1922, pp. 116-118.
16. Correns, C. W.: Über Zwei Einfache Verfahren für das Zentrifugieren mit Schweren Lösungen. *Centr. Mineral.*, Abt. A, no. 6, 1933, pp. 204-207.
17. Dean, R. S.; and Davis, C. W.: Magnetic Separation of Ores. U.S. Bur. of Mines Bull. 425, 1941.
18. Emmons, R. C.: On Gravity Separation. *Am. Mineralogist*, vol. 15, no. 11, Nov. 1930, p. 536.
19. Erwing, C. J. C.: A Comparison of the Methods of Heavy Mineral Separation. *Geol. Mag.*, vol. 68, 1931, pp. 136-140.
20. Fairbairn, H. W.: Concentrations of Heavy Accessories from Large Rock Samples. *Am. Mineralogist*, vol. 40, nos. 5 and 6, May and June 1955, pp. 458-468.
21. Faul, Henry; and Davis, Gordon L.: Mineral Separation with Asymmetric Vibrators. *Am. Mineralogist*, vol. 44, nos. 9 and 10, Sept. and Oct. 1959, pp. 1076-1082.

22. Foster, Wilfrid R.: Gravity Separation in Powder Mounts as an Aid to the Petrographer. *Am. Mineralogist*, vol. 32, nos. 7 and 8, July and Aug. 1947, pp. 462-467.
23. Fraser, F. J.: A Simple Apparatus for Heavy Mineral Separation. *Econ. Geol.*, vol. 23, no. 1, Jan. 1928, pp. 99-100.
24. Frass, Foster: The Conductance Electrostatic Separator. *Trans. AIME*, vol. 153, 1943, pp. 576-587.
25. Frass, Foster: Notes on Drying for Electrostatic Separation of Particles. *Min. Technol.*, vol. 11, no. 6, Nov. 1947, pp. 1-14.
26. Frass, Foster: Electrostatic Separation of Granular Materials. *U.S. Bur. of Mines Bull.* 603, 1962.
27. Frass, Foster: The Matrix-Type Magnetic Separator. *U.S. Bur. of Mines Reports of Investigations* 6722, 1966.
28. Frass, Foster; and Ralston, Oliver C.: Electrostatic Separation of Solids. *Ind. Eng. Chem.*, vol. 32, 1940, pp. 600-604.
29. Fröhlich, H.: Dielectric Constants and Dielectric Loss. *Theory of Dielectrics*. Oxford University Press (Princeton), 1949.
30. Frost, I. C.: An Elutriating Tube for the Specific Gravity Separation of Minerals. *Am. Mineralogist*, vol. 44, nos. 7 and 8, July and Aug. 1959, pp. 886-890.
31. Fuerstenau, Maurice C.: An Improved Flotation Technique. *Eng. and Min. J.*, vol. 165, no. 11, 1964, pp. 108-109.
32. Gad, M. A.; and Le Ridge, H. H.: A Method for Separating the Detrital and Non-Detrital Fraction of Trace Elements in Reduced Sediments. *Geochim. Cosmochim. Acta*, vol. 30, Sept. 1966, pp. 841-846.
33. Gaines, R. V.: Part 2, Métodos de Laboratorio para la Separación de Muestras Minerales. *Mexico Univ. Nac. Autónoma Inst. Geología*, vol. 75, 1965, pp. 17-36.
34. Gaudin, A. M.: Flotation. Second ed., McGraw-Hill Book Co., Inc., 1957.
35. Gaudin, A. M.; and Speeden, H. R.: Magnetic Separation of Sulfide Minerals. *AIME Tech. Pub.* 1549, 13B, 1943.
36. Hallimond, A. F.: An Electromagnetic Separator for Mineral Powders. *Mineral. Mag.*, vol. 22, 1930, pp. 377-381.
37. Hanna, Marcus A.: Separation of Fossils and Other Light Materials by Means of Heavy Liquids. *Econ. Geol.*, vol. 22, no. 1, Jan. and Feb. 1927, pp. 14-17.

38. Harris, R. L., Jr.: A Water Tower Apparatus to Improve Zircon Separation Technique. *Geol. Soc. Am. Bull.*, vol. 76, no. 8, 1965, pp. 971-974.
39. Hatfield, H. S.: Dielectric Separation: A New Method for Treatment of Ores. *Trans. AIME*, vol. 33, Feb. 21, 1924, pp. 335-342.
40. Hess, H. H.: Notes on the Operation of Frantz Isodynamic Magnetic Separator. Instrument Instruction Booklet, S. G. Frantz Co., Inc. (New York), 1959.
41. Hilderbrand, Fred A.: Use of Aerosol in Grain Sorting. *Am. Mineralogist*, vol. 37, nos. 1 and 2, Jan. and Feb. 1952, pp. 129-130.
42. Hirst, D. M.; and Nicholls, Geoffrey D.: Separation of the Detrital and Non-Detrital Fractions of Limestones. Part 1 of Techniques in Sedimentary Geochemistry. *J. Sediment. Petrol.*, vol. 28, no. 4, Dec. 1958, pp. 468-481.
43. Holman, B. W.; and St. Shepard, J. R. C.: Dielectric Mineral Separation: Notes on laboratory work. *Min. Met. Bull.* 233, 1924.
44. Holmes, A.: Petrographic Methods and Calculations. Thomas Murby and Co. (London), 1930.
45. Hutton, C. Osborne: Some Features of Heavy Mineral Separations. *Proc. Roy. Soc. (New Zealand)*, vol. 73, part 2, Sept. 1943, pp. 76-83.
46. Hutton, C. Osborne: Studies of Heavy Detrital Minerals. *Geol. Soc. Am. Bull.*, vol. 61, 1950, pp. 635-716.
47. Jahns, R. H.: Clerici Solution for the Specific Gravity Determination of Small Mineral Grains. *Am. Mineralogist*, vol. 24, no. 2, Feb. 1939, pp. 116-122.
48. Johnson, Herbert B.: Selective Electrostatic Separations. *AIME Tech. Pub.* 877, *Min. Technol.*, vol. 2, Jan. 1938.
49. Jones, M. P.: A Continuous, Laboratory-Size Density Separator for Granular Materials. *Mineral. Mag.*, vol. 35, no. 271, Sept. 1965, pp. 536-541.
50. Kakovskii, I. A.; and Revnivitsev, V. I.: The Effects of Surface Conditioning on the Electrostatic Separation of Minerals of Low Conductivity. *Congr. on Min. Prep. (London)*, vol. 11, 1960, pp. 492-497.
51. Kellagher, R. C.; and Flanagan, F. J.: The Multiple-Cone Sample Splitter. *J. Sediment. Petrol.*, vol. 26, no. 3, Sept. 1956, pp. 213-221.
52. Kittrick, J. A.: The Density Separation of Clay Minerals in Thallous Formate Solutions. *Am. Mineralogist*, vol. 46, nos. 5 and 6, May and June 1961, pp. 744-747.
53. Krumbein, W. C.; and Pettijohn, F. J.: Manual of Sedimentary Petrography. Appleton-Century-Crofts, Inc. (New York), 1938, pp. 320-358.

54. Ksanda, C. J.: An Electromagnetic Separator for Laboratory Use. *J. Opt. Soc. Am.*, vol. 13, 1926.
55. Kunitz, W.: Eine Schnellmethode der gravimetrischen Phasenanalyse mittels der Zentrifuge. *Centr. Mineral., Abt. A*, 1931, pp. 225-232.
56. Lillie, Ralph W.: *Histopathologic Technic and Practical Histochemistry*. Blakiston Company, Inc. (New York), 1954, pp. 93-114.
57. Loeb, Leonard B.: *Static Electrification*. Springer-Verlag (Berlin), 1958, pp. 164-190.
58. McAndrew, J.: Calibration of a Frantz Isodynamic Separator and its Application to Mineral Separation. *Australian Inst. Min. Met. Proc.*, vol. 181, May 1957, pp. 59-73.
59. Mathisrud, Gordon C.: Magnetic Separations in Petrography. *Am. Mineralogist*, vol. 27, no. 9, Sept. 1942, pp. 629-637.
60. Milner, Henry B.; Ward, A. M.; and Higham, Frank, eds.: *Methods In Sedimentary Petrography*. Vol. I of *Sedimentary Petrography*. Fourth ed., MacMillan Co., 1962, pp. 119-123.
61. Modarresi, Hassan G.: Simple and Effective Device for Gravity Separation of Heavy Mineral Grains. *J. Sediment. Petrol.*, vol. 38, no. 1, Mar. 1968, pp. 240-242.
62. Muller, L. D.: The Micropanner. An Apparatus for the Gravity Concentration of Small Quantities of Materials. *Trans. AIME*, vol. 623, 1958, pp. 1-7.
63. Neuerburg, George J.: A Method of Mineral Separation Using Hydrofluoric Acid. *Am. Mineralogist*, vol. 46, nos. 11 and 12, 1961, pp. 1498-1501.
64. Nickel, E. H.: A New Centrifuge Tube for Mineral Separation. *Am. Mineralogist*, vol. 40, nos. 7 and 8, July and Aug. 1955, pp. 697-699.
65. O'Connell, W. L., Jr.: Properties of Heavy Liquids. *Trans. AIME*, vol. 226, 1963, pp. 126-132.
66. Officer, V. C.: A New Laboratory Separator for Mineral Sands. *New Zealand J. Sci. Technol.*, vol. 29(B), 1947, p. 133.
67. Parks, G. A.; Jindal, K. B.; and Anderson, J. H., Jr.: Temperature and Humidity in Electrical Separation of Oxide Minerals. *Trans. AIME*, vol. 235, no. 4, 1966, pp. 451-457.
68. Pohl, Herbert A.; and Plymale, Charles E.: Continuous Separation of Suspensions by Non-Uniform Electric Fields in Liquid Dielectrics. *Plastics Laboratory Tech. Rept. 53B*, Dept. of Army Proj. 3-99-15-108, Princeton University, 1959.

69. Pohl, Herbert A.; and Schwar, J. P.: Factors Affecting the Separation of Suspension in Non-Uniform Electric Fields. *J. Appl. Phys.*, vol. 30, no. 1, Jan. 1959, pp. 69-73.
70. Pollack, Jerome M.: Removal of Heavy Liquid Separates from Glass Centrifuge Tubes — Additional Suggestions. *J. Sediment. Petrol.*, vol. 32, no. 3, 1962, p. 607.
71. Pryor, E. J.: *Mineral Processing*. Third ed., Elsevier Pub. Co. (Amsterdam, N. Y.), 1965.
72. Ralston, Oliver C.: *Electrostatic Separation of Mixed Granular Solids*. Elsevier Pub. Co. (Amsterdam, N. Y.), 1961.
73. Ray, Satyabrata; Gault, H. R.; and Dodd, Charles G.: The Separation of Clay Minerals from Carbonate Rocks. *Am. Mineralogist*, vol. 42, nos. 9 and 10, Sept. and Oct. 1957, pp. 681-686.
74. Rodda, J. L.: Microseparation of Minerals in Heavy Liquids. *Am. Mineralogist*, vol. 36, nos. 8 and 9, July and Aug. 1951, pp. 625-626.
75. Rosenblum, Sam: Magnetic Susceptibilities of Minerals in the Frantz Isodynamic Magnetic Separator. *Am. Mineralogist*, vol. 43, nos. 1 and 2, Jan. and Feb. 1958, pp. 170-173.
76. Rosenholtz, J. L.; and Smith, D. T.: The Dielectric Constant of Mineral Powders. *Am. Mineralogist*, vol. 21, no. 2, Feb. 1936, pp. 115-120.
77. Ross, Clarence S.: Preparation of Sedimentary Materials for Study. *Econ. Geol.*, vol. 23, no. 3, May 4, 1928, p. 334.
78. Schon, Robert; and Lee, D. E.: Successful Separation of Silt-Size Minerals in Heavy Liquids. *U.S. Geol. Surv. Res. Prof. Paper 501*, pp. B154-157.
79. Schroeder, Fritz: Scheidetrichterzum Einsetzen in die Zentrifuge beim Trennen von Mineralgemischen mit Schweren Fleissigkeiten, *Contr. Mineral.*, Abt. A, 1930, pp. 38-46.
80. Sclar, Charles B.; and Weissberg, Alfred: Density Chart for the Preparation of Heavy Liquids for Mineralogical Analysis. *Trans. AIME*, vol. 220, 1961, pp. 349-351.
81. Scull, Bertson J.: Removal of Heavy Liquid Separates from Glass Centrifuge Tubes — Alternative Method. *J. Sediment. Petrol.*, vol. 30, no. 4, Dec. 1960, p. 626.
82. Senftle, F. E.: Apparatus for the Separation of Mineral Grains. *Am. Mineralogist*, vol. 36, nos. 11 and 12, Nov. and Dec. 1951, pp. 910-912.

83. Smales, A. A.; and Wager, L. R., eds.: *Methods in Geochemistry*. Interscience Pub., Inc. (New York), 1960.
84. Steacy, H. R.: A Method for Separation of Mineral Grains From Sized Products. *Am. Mineralogist*, vol. 37, nos. 5 and 6, May and June 1952, pp. 550-551.
85. Sullivan, J. D.: *Heavy Liquids for Mineralogical Analyses*. U.S. Bur. of Mines Tech. Paper 381, 1927.
86. Taggart, Arthur F.: *Handbook of Mineral Processing*. Chapman and Hall (London), 1945.
87. Taylor, Garvin L.: A Centrifuge Tube for Heavy Mineral Separations. *J. Sediment. Petrol.*, vol. 3, no. 1, Apr. 1933, pp. 45-46.
88. Vassar, Helen E.: Clerici Solution for Mineral Separation by Gravity. *Am. Mineralogist*, vol. 10, no. 5, May 1925, pp. 123-125.
89. Verschure, R. H.; and Ijlst, L.: Apparatus for Continuous Dielectric-Medium Separation of Mineral Grains. *Nature*, vol. 211, no. 5049, Aug. 6, 1966, pp. 619-620.
90. Verschure, R. H.; and Ijlst, L.: The Intracentrifuge: A Device for Continuous Separation of Heavy Minerals. *Mineral. Mag.*, vol. 35, no. 276, Dec. 1966, pp. 1165-1167.
91. Vincent, H. C. G.: Mineral Separation by an Electrochemical Magnetic Method. *Nature*, vol. 167, 1951, p. 1074.
92. Von Wolff, F.: Die Trennung fester Phasen durch die Zentrifuge. *Centr. Mineral.*, Abt. A, 1927, pp. 449-452.
93. Wager, L. R.; and Brown, G. M.: Collection and Preparation of Material for Analysis. *Methods in Geochemistry*, ch. II, A. A. Smales and L. R. Wager, eds., Interscience Pub., Inc. (New York), 1960, pp. 4-32.
94. Woo, C. C.: Heavy Media Column Separation: A New Technique for Petrographic Analysis. *Am. Mineralogist*, vol. 49, nos. 1 and 2, Jan. and Feb. 1964, pp. 116-126.
95. Woodford, Alfred O.: Methods for Heavy Mineral Investigations. *Econ. Geol.*, vol. 20, no. 1, 1925, pp. 103-104.
96. Woodley, D. J. A.; and Duffell, C. H.: A High-Tension Disc Separator. *Min. Mag.*, vol. 111, 1964, pp. 313-315.
97. Zussman, J., ed.: *Physical Methods in Determinative Mineralogy*. Academic Press (New York), 1967.

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